which were peculiar to their suppers, and inquiry was at once directed to these oysters. It was found that they had been obtained from the deep water of Long Island Sound and had been deposited in the mouth of a fresh water creek to freshen, or to 'fatten,' as it is termed, since under such circumstances the oyster absorbs the fresh water by osmosis and therefore swells and becomes plump. Further inquiry showed that, within about three hundred feet of the place where the oysters had been deposited, was the outlet of a private sewer coming from a house in which were two cases of typhoid fever at the time when the oysters were taken up and sent to the University.

The typhoid bacillus will live for a time in salt or brackish water, and it was proved by trial that if such bacilli are forced in between the two valves of the shell they remained alive long enough to enable the oysters to be carried and used at the fraternity suppers. Whether the bacillus will grow and multiply in living or dead oysters has not yet been determined, but experiments on this point are in progress.

It will be seen that the evidence that the outbreak of typhoid was produced by these oysters is purely circumstantial, but the links in the chain are well connected and strong.

It is by no means certain that there were any typhoid germs within the oysters or the oyster shells when they were sent to Middletown. If the shells were smeared on the outside with typhoid excreta some particles of this might easily have gotten among the oysters during the process of opening them. But it is evident that oysters grown or fattened in positions where sewage may come in contact with them are dangerous if eaten raw.

THE EVOLUTION OF INVENTION.

In a recent study that I have made on the evolution of invention I have divided the changings which underlie all examples of the process into those—

1. Of the thing or process, commonly called inventions.
2. Of the apparatus and methods used.
3. Of the rewards to the inventor.
4. Of the intellectual activities involved.
5. Of society.

Each one of these has undergone an evolution or elaboration, from monorganism to polyorganism, from simplicity to complexity, from individualism to coöperation, from use to comfort, and so on. This statement needs no extended proof; the roller mill is the descendant of the metals, machinery springs from tools, the device beneficial only to its originator becomes the world-embracing and world-blessing invention; the happy thought of one person at last comes to be the beneficent result of an endowed and perennial coöperation, a perpetual repository of invention renewed constantly by the removal of the senescent and the introduction of new and trained minds as in a university.

Now it requires great patience to get together the material evidence of this unfolding or evolution. The mental processes are no longer in sight. The nearest approach to them are the makeshifts of savages, and their minds are almost a sealed book. It has therefore occurred to the writer that among the questions proposed to those who are collating information relating to the psychic growth of children there should be a short series respecting the unfolding of the inventive faculty or process, the finding out originally how to overcome new difficulties or surmounting old ones in new ways.

O. T. Mason.

SCIENTIFIC LITERATURE.

Popular Lectures and Addresses.—Vol. II., Geology and General Physics.—Lord Kelvin.—Macmillan & Co., New York and London. Pp. 599. Price $2.00.

It is characteristic of the work of a really great genius, either in Science, Literature or Art, that it is not displaced and cannot be displaced by that which may come after it.

A bit of scientific work may later be found to be erroneous as to data, and, therefore, in the wrong as to conclusions, but if it be the work of an aggressive, original thinker, it will always have great value. In the brilliant galaxy of physicists, or, as he would himself call them, natural philosophers, which the present century has produced, it is moderation to say that none outshines Lord Kelvin, and it will not be denied that none has equalled him in aggressiveness and originality. The range of subjects upon which he has touched during his long and active life is so extensive as to certainly justify the use of the term Natural Philosopher in its broader sense (and capitalized at that), for he has never touched a department of human knowledge without leaving it richer and more extensive for his contact with it. That he has not been invariably infallible is recognized by no one more fully than by himself, and the new editions of his earlier papers which have been issuing from the press at intervals during the past few years, bear most interesting evidence of his readiness to change his attitude on great questions whenever the verdict of later investigations is against him. It is delightful to note the occasional parenthetical '*not*' put to-day into a sentence which twenty years ago declared very positively that '*there is*' so and so, or, '*we can*,' etc., completely reversing the meaning of statements which were once made with a good degree of confidence. Whatever else may be said, it cannot be asserted that Lord Kelvin has ever lacked the courage to express his own views in most forcible and unmistakable language. Indeed, in this respect, especially, he has set a splendid standard of unswerving scientific honesty for the innumerable workers who have been, and will be, more or less influenced by his methods and their tremendous productiveness.

His views as to the proper attitude of the philosopher in his relations to unexplored regions of human experience are concisely expressed in this noble sentence from his Presidential Address before the British Association for the Advancement of Science, in 1871: "Science is bound by the everlasting law of honor to face fearlessly every problem which can fairly be presented to it." When he comes, however, to touch upon some problems which have long been of great interest to the human race, but which have been assumed, usually, to lie outside the domain of experimental or exact science (and he touches upon them not infrequently in the volume under consideration), it is not difficult to see a very decided bias towards certain views, and a promptness to accept propositions not always well supported by evidence, very greatly in contrast with what is found in more vigorously scientific discussion.

This series of popular lectures and addresses is published in three volumes, the first and third having already appeared. The second (issued later than the third), to which attention is now invited, contains the important addresses on geological physics which have attracted so much attention during the past quarter of a century, together with a number of lectures and short papers on subjects related to general physics and extracts from addresses as president of the Royal Society since 1890. The geological papers are of great interest and have had much to do with the moulding of the views of geologists as to Dynamical Geology. The series begins with a short note covering but a single octavo page, entitled, '*The Doctrine of Uniformity in Geology Briefly Refuted*,' read at Edinburgh in 1865. It fairly 'opens the ball,' and may be regard-

ed as the key note to the more elaborate disquisitions which followed at intervals up to recent dates. These papers are so well known, or ought to be so well known, to all geologists as to make it only necessary to say here that they will be found collected in this volume in convenient form and with a few notes and occasional comments by the distinguished author, made while the collection was being prepared for the press. The most important of the earlier papers are the address '*On Geological Time*,' given in Glasgow, early in 1868, and that on '*Geological Dynamics*' at the same place about a year later. In the first of these will be found the somewhat severe strictures upon '*British Popular Geology*' which brought forth the interesting and pointed criticisms of Huxley in his address to the Geological Society of London, and in the second the replies to Huxley's criticisms and futher remarks upon the subject. Nearly ten years later came a '*Review of the Evidence Regarding the Physical Condition of the Earth*,' read at the British Association meeting at Glasgow; two papers read before the Geological Society of Glasgow, on '*Geological Climate*,' and on the '*Internal Condition of the Earth*;' and after the lapse of another ten years a paper before the same society on '*Polar Ice Caps and their Influence in Changing Sea Levels*.' In these much of the ground of the earlier addresses is again gone over, in the light of later discovery in geology, physics and astronomy.

Indeed these same topics recur again and again, sometimes incidentally in other addresses in the volume, and Lord Kelvin makes it entirely clear that in thus taking up the discussion of geological problems and applying to them the methods and data of physics and astronomy, he does not wish to be considered an interloper. In his reply to Huxley, who had rather pointedly intimated that view of the situation, he good-naturedly remarks: "For myself I am anxious to be regarded by geologists, not as a mere passer-by, but as one constantly interested in their grand subject, and anxious in any way, however slight, to assist them in their search for truth."

It seems difficult to over-estimate the importance of these geological addresses, not only to the geologist, but to the physicist as well. They not only have a general interest to both, but are of special importance to each. To the one they open new possibilities of a somewhat exact and satisfactory treatment of a most important but hitherto rather unmanageable department of his subject; and to the other they offer a most instructive illustration of the power and scope of the methods of exact science, when applied by one who may justly be called not a master, but *the* master.

Of the other addresses, none, of course, is more important or interesting than the British Association Presidential Address of 1871, so well known to all. One of the earliest, on '*The Rate of a Clock or Chronometer as Influenced by the Mode of Suspension*,' is most entertaining and suggestive as an example of the many 'side-lights' of a remarkable intellectual activity. Of great historical value is the Royal Institution lecture of 1856 on the '*Origin and Transformation of Motive Power*'—already republished in Volume II. of the '*Mathematical and Physical Papers*;' and one of the most interesting is that of late date (1892) on the '*Dissipation of Energy*.' In this much attention is given to the principle of Carnot, and here also occurs a remarkable statement which the author himself has thought worth while to print in italics;—it is:—"*The fortuitous concourse of atoms is the sole foundation in Philosophy on which can be founded the doctrine that it is impossible to derive mechanical effect from heat otherwise than by taking heat from a body at a higher temperature, converting at most a definite proportion of it into mechanical effect, and giving out the whole residue to matter at a lower temperature.*"

The address on the opening of the Bangor Laboratories will be of interest to all who have to do with their like; that on the occasion of the unveiling of Joule's statue will interest everybody who cares for or who knows of the greatest generalization of modern science. In short, every page of this volume is deserving of the careful perusal of all who are devoted to Natural Philosophy in its most comprehensive sense, and who wish to know something of the spirit of one whose splendid contributions to physical science are, as a whole, greater than those of any other philosopher of the present time.

The mechanical execution of the book does not seem to be quite in keeping with the classical character of its contents, and its pages are occasionally marred by negligent proof reading. T. C. MENDENHALL.

WORCESTER POLYTECHNIC INSTITUTE.

Laws of Temperature Control of the Geographic Distribution of Life.

In the December issue of the *National Geographic Magazine*, Dr. C. Hart Merriam announces the discovery of the laws of temperature control of the geographic distribution of terrestrial animals and plants. Dr. Merriam has been engaged on this problem for sixteen years and believes he has at last obtained a formula which fulfills the requirements. He states that in the Northern Hemisphere animals and plants are distributed in circumpolar belts, the boundaries of which follow lines of equal temperature rather than parallels of latitude. Between the pole and the equator there are three primary belts or regions—Boreal, Austral and Tropical. In the United States the Boreal and Austral have each been split into three secondary transcontinental zones, of which the Boreal are known as the Arctic, Hudsonian and Canadian; and the Austral as the Transition, Upper Austral and Lower Austral.

The temperature data computed and plotted on maps as isotherms are not available in locating the boundaries of the zones, because they show the temperature of arbitrary periods—periods that have reference to a particular time of year rather than a particular degree or quantity of heat.

It is assumed that the distribution of animals and plants is governed by the temperature of the season of growth and reproductive activity—not by that of the entire year. The difficulty is to measure the temperature concerned.

Physiological botanists have long maintained that "the various events in the life of plants, as leafing, flowering and maturing of fruit, take place when the plant has been exposed to a definite quantity of heat, which quantity is the sum total of the daily temperatures above a minimum assumed to be necessary for functional activity." The minimum used by early botanists was the freezing point (0° C or 32° F), but recent writers believe that 6° C or 42.8° F more correctly expresses the temperature of the awakening of plant life in spring. "The substance of the theory is that *the same stage of vegetation is attained in any year when the sum of the mean daily temperatures reaches the same value*, which value or total is essentially the same for the same plant in all localities. This implies that the period necessary for the accomplishment of a definite physiological act, blossoming, for instance, may be short or long, according to local climatic peculiarities, but the total quantity of heat must be the same. The total amount of heat necessary to advance a plant to a given stage came to be known as the *physiological constant* of that stage." But students of geographic distribution are not concerned with the physiological constant of any stage or period in the life of an organism, but with *the physiological constant of the species itself*—if such a term may be used. "If it is true that the same stage of vegetation is